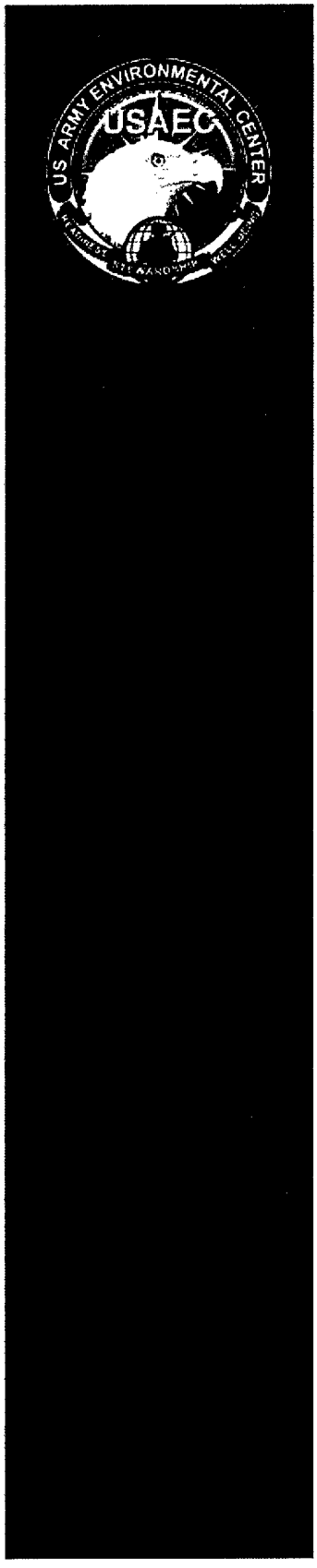

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Corrosion of Buried Mines

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13. ABSTRACT (Maximum 200 words)

This paper discusses how observations of corrosion in buried mines can improve our ability to predict corrosion in steel munitions buried in the US (i.e., unexploded ordnance (UXO)). It proceeds from the hypothesis that the corrosion that takes place in metals, joints, dissimilar metal interfaces, etc., that are present in mines, may be correlated with corrosion in UXO. Listings of buried landmines having steel casings are presented, along with country of origin and limited design information.

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1. INTRODUCTION

A previous study [1] for the U.S. Army Environmental Center (USAEC) to determine the factors that influence the degradation of unexploded ordnance (UXO) was performed under TRMS No. 9-CO-160-000-571. That study reported that there are many thousands of UXO items buried on practice and test firing ranges in the United States, but their condition was unknown. Many of them may be partially cracked, degraded or perforated by corrosion.

All UXO present an obvious explosive safety hazard, but because the fill components have unique toxicological and physicochemical properties, they may also present a potential environmental risk. Should the shell casings or fuse bodies become perforated due to corrosion, significant impacts to surface water and groundwater quality could result. The study concluded that the environmental risks posed at U.S. military installations containing UXO remain undefined. Understanding the relative rate of UXO corrosion would help determine the environmental risks posed by the energetic and constituent materials of UXO.

The study addressed two fundamental questions regarding UXO in soils:

- How fast do UXO corrode?
- What environmental factors influence the corrosion rate?

An equation and computer model for the prediction of the corrosion of UXO in soils had been developed by the Corrosion Research Center (University of Louisiana-Lafayette), and it was presented and discussed in the study. (That tool is referred to as "the ULL regression equation.")

The prediction ability of the ULL regression equation at present is uncertain because the empirical data upon which it is based is extremely limited. It was thought that the database could be expanded by including measurements taken during landmine clearing operations. As a first step in that direction, this paper discusses buried mines and how they might be used to improve the usefulness of the ULL regression equation.

2. OBJECTIVE

The objectives of this paper are:

To discuss how to use observations of corrosion in buried mines to improve our ability to predict corrosion in steel munitions buried in the US (i.e., UXO).

3. METHODS AND SOURCES

The first step, addressed in this paper, was to query the available technical and non-technical literature for candidate mines suitable for use with the UXO Corrosion Model. The second step would be to collect corrosion data on recovered mines and use it to refine the ULL regression equation. As some of that data is likely to relate to foreign mines, it may be beneficial to seek design information for the recovered mines. The U.S. Army Ordnance Museum has a foreign mines collection that may be examined by appointment.[2] The museum anticipates the addition of a complete collection of U.S. mines in the near future.[3]

---

[1] Ostazeski, Stan, "Corrosion of Unexploded Ordnance," USAEC Report No. SFIM-AEC-PC-CR-2002041, November 2002.

[2] Atwater, William E., Ph.D., Director/Curator, US Army Ordnance Museum, Attn: ATSL-DOS-M, APG, MD

[3] Heasley, E., Curator, US Army Ordnance Museum, Attn: ATSL-DOS-M, APG, MD. Private communication,

Additional information concerning mine corrosion can be obtained from the Corrosion Protection and Control Office, ARDEC, Attn: AMSTA-AR-WEA (Mr. Joel Senske), Picatinny Arsenal, Dover, NJ. Specific design information for U.S. landmines is also available from ARDEC, Attn: AMSTA-AR-FSP-M (Mr. Len Mering), Picatinny Arsenal, Dover, NJ.

Other potential resources for information on the corrosion of buried mines are the landmine detection test facilities at Aberdeen Proving Ground[4] and Yuma Proving Ground[5]. These sites maintain minefields for the purpose of countermine system testing and training. Mine conditions and soil properties are regularly monitored. Many of the mines have been in place since 1998.

4. RESULTS AND DISCUSSION

The ORDATA II database listed 414 metal landmines, 17 scatterable metal munitions (surface-emplaced landmines), and two naval metal landmines from 39 countries. The United States mines listed in the database included 43 metal landmines, 41 scatterable metal munitions and one naval metal mine. Twenty-two of the Unites States metal landmines and two underwater metal mines were listed in the Munitions Items Disposition Action System (MIDAS) database. This MIDAS library contains detailed characterizations of munitions and their constituents. The library also identifies the applicable mine and mine case specifications. The mines that are considered applicable for this corrosion study would be only those that are emplaced underground in soil and that also have steel casings. See Table 1 for international mines and Table 2 for U.S. mines.

There are descriptions in ORDATA II of artillery projectiles that have been converted into antipersonnel mines by the addition of a special fuze. Such items would be especially applicable to a corrosion study aimed at improving predictions of corrosion in UXO.

Landmine/case specifications (for U.S mines) can be found on the Acquisition Streamlining and Standardization Information System (ASSIST). ASSIST-Online is a robust, comprehensive web site providing access to current information associated with military and federal specifications and standards in the management of the Defense Standardization Program. ASSIST is the official source of DoD specifications and standards. ASSIST provided the military standards and some ASTM information identified in the MIDAS library.

Romanoff[6] described the four major factors in corrosion processes as:

- Aeration - Soils that are physically permeable to air and water will contribute to accelerated corrosion rate.
- Electrolyte - Soils that contain soluble salts and sufficient moisture will supply cations and anions that stimulate metal corrosion processes.
- Electrical - Acceleration of corrosion results from differences in electrical potential from one region of a munition to another.
- Miscellaneous - Soil bacteria increase the electrical conductivity and decrease pH of the soil, both of which would accelerate UXO corrosion.

September 2002.

[4] U.S. Army Aberdeen Test Center, Firepower Core, Special Ordnance Team, ATTN: CSTE-DTC-AT-FC-S, 400 Colleran Rd., Aberdeen Proving Ground, MD 21005-5059, telephone 410-278-4343.

[5] U.S. Army Yuma Proving Ground, Munitions & Weapons Division, ATTN: CSTE-DTC-YP-YT-GC-EW, Mr. Steve Patane, Yuma, AZ 85365, telephone 928-328-7161.

[6] Romanoff, M. 1957. Underground Corrosion. Vol. National Bureau of Standards Circular 579. U.S. Department of Commerce, National Bureau of Standards, Washington D.C. 222 pages.

The main source of electrical potential differences is the presence of dissimilar metals in the munition. These dissimilarities may result from the use of different metals for components in contact with each other or from differences at the microstructure level that arise during the forming process, the heat treatment process, and from deformation that occurs during deployment of the munition. In general, if the anode area is small and the cathode area is relatively large, localized corrosion may be severe.

When corrosion causes perforation of a munition casing, dissolution of the explosive filler could cause changes in the local electrochemistry of the soil, possibly causing corrosion rate to increase significantly. If the munition casing were already leaking when it was first buried, its corrosion rate would be expected to be higher than if it were intact.

Landmines and artillery projectiles normally have paint or other protective coatings. However, these coatings are usually damaged or completely stripped when artillery projectiles impact the soil[7]. For this reason, correlation of UXO corrosion with landmine corrosion requires data on the durability of the protective coatings on the landmines, i.e., the time from first emplacement until the protective coating begins to fail.

5. CONCLUSIONS

A large proportion of the landmines that may be encountered during demining operations around the world, such as those identified in this paper may yield empirical soil corrosion data. Demining operations normally attempt to identify the munitions encountered, but they are not normally recovered intact and demilitarized. Nevertheless, if metal fragments from identified mines were recovered, some of them could provide useful corrosion rate measurements.

Minefields with training mines or mines with inert fuzes could also be a valuable source of corrosion data, with the additional benefit that they could be safely recovered intact.

In order to use the recovered fragments to refine the ULL corrosion equation, the following information would also be required:

- An estimate of how long the mines had been buried in the soil.
- Identification of the mines and essential design specifications, to include:
    - Primary casing material, heat treatment and forming method, i.e., casting, forging, cold rolling, stamping, etc.
    - Casing thickness(es)
    - Joining methods used in the casing, i.e., welding, threading, pressing, screws, rivets, pins.
    - Dissimilar metals used in the casing or joined to it.
    - Explosive fill or inert simulant used.
- Measurements of certain soil properties where the mine fragments were buried:
    - Temperature
    - Presence of soil moisture
    - Average annual rainfall
    - Dissolved solids
    - Soil pH
    - REDOX state of the soil

[7] Schnell, R., Aberdeen Test Center, APG, MD. Private communication, September 2002.

- Minimum soil resistivity
- Soil permeability
- Total alkalinity
- Total calcium (as $CaCO_3$)
- Presence of bacteria.

6. REFERENCES

The following sources were consulted for information on landmines:

- "Landmines and Demining" (Interactive CD-ROM), National Ground Intelligence Center, 220 Seventh Street, NE, Charlottesville, VA 22902
- "ORDATA II" (Database), NAVEODTECHDIV, ATTN: Code 62, 2008 Stump Neck Road, Indian Head, MD 20640-5070
- Munitions Items Disposition Action System (MIDAS) (Database)
- Acquisition Streamlining and Standardization Information System (ASSIST)

ABBREVIATIONS AND ACRONYMS

Term	Definition
UXO	Unexploded Ordnance
ASSIST	Acquisition Streamlining and Standardization Information System
MIDAS	Munitions Items Disposition Action System Database
ORDATA II	Ordnance Database
REDOX	Reduction/Oxidation
ULL	Corrosion Research Center, University of Louisiana-Lafayette
USAEC	U.S. Army Environmental Center
TRMS	Test Resources Management System (US Army Development Test Command)

Table 1. Applicable International Mines Listed in ORDATA II Database

Country of Origin	Model Designation	Type of Munition	Case Material	Remarks
Austria	PM 83	antitank	unknown	---
Austria	PM 3000	antitank	unknown	---
Belgium	NR 442	antipersonnel	metal	Bounding type
Brazil	T-AB-1	antipersonnel	metal	---
Brazil	MIN AC AP NM AE T-AB-1	antitank	metal	---
Bulgaria	POMD-1	antipersonnel	metal	---
Bulgaria	PSM-1 (Bounding)	antipersonnel	metal	---
Bulgaria	OM-1-SHM (Delayed-action)	---	metal	---
Chile	U/I	antipersonnel	metal	---
China	No. 4 (M1A1 copy)	antitank	---	---
China	Type 81	signal/alarm	plastic/steel	---
China	Type 69 (Bounding)	antipersonnel	steel/cast iron	---
China	Type 84	antitank	sheet steel	---
China	Similar to U.S.S.R. TM-41	antitank	sheet metal	---
China	Type 72MT	antitank	metal	---
China	Electronic	antipersonnel	---	---
Czechoslovakia	PP MI-SR II	antipersonnel	steel or plastic	---
Czechoslovakia	PT MI-P	antitank	metal	---
Czechoslovakia	PT-MI-K	antitank	steel	---
Czechoslovakia	Plate Charge/Heat	---	sheet metal	---
Czechoslovakia	PT MI-BA II (Variant)	antitank	metal	---
Czechoslovakia	PP-MI-SB	antipersonnel	---	---
Czechoslovakia	PP-MI-SR	antipersonnel	steel	---
Czechoslovakia	PT-MI-K2(II)	antitank	---	---
Denmark	PM M/47-1	antitank	steel	---
Egypt	U/I (Bounding)	antipersonnel	metal	---
Egypt	M/71	antitank	sheet metal	---

Country of Origin	Model Designation	Type of Munition	Case Material	Remarks
Egypt	Bounding/Stake	antipersonnel	metal	---
Egypt	Unknown	antitank	metal	---
Egypt	Incendiary	apers/antimateriel	metal	---
Egypt	UI Bounding Fragmentation Stake	antipersonnel	metal	---
Egypt	Bounding	antipersonnel	metal	---
Egypt	Fragmentation	antipersonnel	steel	---
Egypt	Illuminating	signal/alarm	sheet metal	---
Finland	KVKM 73	antitank	metal	---
Finland	SICA OY	antitank	metal	---
Finland	KVKM 73 FRAG	apers/antitank	steel	---
Finland	KVKM 81	antitank	metal	---
France	MI AC CP.1 Plate	antitank	steel	---
France	Heavy	antitank	steel	---
France	MI AP ED.1 (Plate-charge Frag)	antipersonnel	sheet steel	---
France	MI AC X35 (Training)	antitank	steel	Training mines could also provide useful corrosion data
France	GIAT LANCE	antitank	metal	---
France	M AZ AC	antitank	metal	---
France	Light	antitank	metal	---
France	U/I Directed Fragmentation	antipersonnel	sheet metal	---
France	ACL 89	antitank	metal	---
France	L14A1	antitank	metal	---
France	MI AC ARGES	antitank	metal or plastic	---
France	MI AC CP.1 (Plate Charge)	antitank	sheet metal	---
France	MI AC PED GIAT	antitank	plastic and metal	---
France	1951/55 (Bounding)	antipersonnel	metal	---
France	1948	antipersonnel	metal	---

Country of Origin	Model Designation	Type of Munition	Case Material	Remarks
France	Directed Frag	antipersonnel	metal	---
France	MI AC DISP F1	antitank	metal	---
France	U/I Fragmentation-plate charge	antivehicle	sheet steel	---
France	51/55 (Bounding)	antipersonnel	steel	---
France	Frag Plate Charge	antipersonnel	metal	---
France	Type 542-L (Undetectable)	antitank	metal	---
France	1954	antitank	metal	---
France	Frag Plate Charge	antitank	metal	---
France	HPD 3	antitank	metal	---
France	1953	antitank	metal	---
France	ACPM	antitank	metal	---
France	HPD 2	antitank	metal	---
France	HPD F2	antitank	metal	---
France	MACIPE	antitank	metal	---
France	1948 (Metallic)	antitank	steel	---
France	MIACAH F1, and Practice, MIACAH XF1	antitank	steel	---
France	MITRAL	antitank	metal	---
France	Plate Charge	antitank	metal	---
France	1948T (Plate Charge)	antitank	steel	---
France	1951 (Metallic, Shaped Charge)	antitank	steel	---
France	1956	antitank	steel	---
France	1948 (Plate Charge)	antitank	steel	---
France	48/55 (Plate Charge)	antitank	steel	---
France	MI ECL FIXE 50	illumination	metal	---
France	MI ECL FIXE LDU F1	illumination	metal	---
France	MI AC X 51	training	steel	---
France	MI ECL FIXE 56	illumination	metal	---

Country of Origin	Model Designation	Type of Munition	Case Material	Remarks
France	MI ECL FIXE LDU F1 A, B	illumination	metal	---
Germany	DM39A1	antilift	sheet metal	---
Germany	Dynamine (AP)	antipersonnel	metal	---
Germany	Dynamine (AM)	antitank	metal	---
Germany	MIFF	antitank	metal	---
Germany	DM-41	antipersonnel	metal	---
Germany	MUSPA	antipersl/material	metal	---
Germany	L.PZ.MI	antitank	sheet steel	---
Germany	MINOS	antitank	plastic and metal	---
Germany	R.MI.43	antitank	sheet steel	---
Germany	T.MI.35(S)	antitank	sheet steel	---
Germany	Tellermine 43	antitank	metal	---
Germany	DM49, & Anti-lift Device, Practice, DM68	antipersonnel	metal	---
Germany	SPR.R.MI.	antitank	sheet metal	---
Germany	T.MI.35	antitank	sheet steel	---
Germany	Tarantel	antitank	metal	---
Germany	Tellermine 42	antitank	metal	---
Germany	DM-31 & Practice, DM-28	antipersonnel	steel	---
Germany	K-2	antipersonnel	metal	---
Germany	1233 (AT-2) DM	antitank	steel	---
Germany	DM-40 (Practice)	antitank	---	---
Germany	SM-70-501, SM-70-601, and SM-70-701	antipersonnel	metal	---
Germany	DM-11	antitank	metal	---
Germany	PARM 1	antitank	metal	---
Germany	Dynamine (Shallow Water)	---	metal	Shallow water mines provide useful corrosion data if buried near riverbank
Greece	M16A2 (copy)	antipersonnel	sheet steel	---

Country of Origin	Model Designation	Type of Munition	Case Material	Remarks
Greece	Pyrkal	antitank	metal	---
Hungary	36	antipersonnel	metal	---
Hungary	UKA-63	antitank	metal	---
Hungary	CVP-1 (Dual-Purpose)	multipurpose	steel and brass	---
Hungary	RAMP	antipersonnel	sheet metal	---
Hungary	U/I (Bounding)	antipersonnel	metal	---
India	M16A1 (copy)	antipersonnel	Sheet steel	---
Israel	No. 2	antipersonnel	metal	---
Israel	No. 16	antitank	metal	---
Iran	M18A1 (copy)	---	---	---
Iran	M19 (copy)	antitank	---	---
Italy	Picket	antipersonnel	thin sheet metal	---
Italy	U/I IT (Stake)	antipersonnel	metal	---
Italy	SATM	antitank	metal	---
Italy	V	antipersonnel	metal	---
Italy	B2	antitank	sheet metal	---
Italy	V5	antipersonnel	metal	---
Italy	VS-SAPFM3	antipersonnel	metal	---
Italy	BM/85 (Bounding)	antipersonnel	metal	---
Italy	VALMARA	antipersonnel	plastic or sheet metal	---
Italy	VS-ER-83	antipersonnel	---	---
Italy	VS-SATM1	antitank	metal	---
Italy	MAL/17	shallow-water	metal	---
Italy	VALMARA 59	antipersonnel	plastic or sheet metal	---
Italy	VAR/IG (Illuminating)	warning	---	---
Italy	Ratchet	railway	metal	---
Italy	MAS/22	shallow-water	metal	---

Country of Origin	Model Designation	Type of Munition	Case Material	Remarks
Japan	Type 67 (M25 copy)	antipersonnel	---	---
Japan	Hemispherical, 5-KG	antitank	steel	---
Japan	Yardstick	antivehicular	sheet steel	---
Japan	Dutch	antipersonnel/tank	pressed steel	---
Japan	LUNGE	antitank	steel	---
Japan	Type 93	antipersonnel/tank	metal	---
Japan	Type 80	antipersonnel	metal	---
Multiple Country	MZU-2	antivehicle	metal	---
Multiple Country	MZS (Delayed-Action)	demolition	metal	---
Multiple Country	MZU-S	antivehicle	steel	---
Netherlands	NR 23	antipersonnel	steel	---
Netherlands	NR-25	antitank	steel	---
Netherlands	25	antitank	steel	---
Netherlands	T40, Type 2	antitank	steel	---
North Korea	ATM-46	antitank	metal	---
North Korea	ATM-41	antitank	metal	---
North Korea	ATM-72	antitank	metal	---
North Korea	OZM-3	antipersonnel	metal	---
North Korea	ATM-46N	antitank	metal	---
North Korea	ALCM-82 (Shallow Water)	shallow water	steel	---
Pakistan	P5 Mark 1 (M18A1 copy)	antilanding-craft	---	---
Pakistan	P7 MK 1 (Jumping)	antipersonnel	metal	---
Pakistan	P3 MK 2	antipersonnel	metal	---
Poland	MN-111	antitank	sheet steel	---
Poland	MN-121	antitank	sheet metal	---
Portugal	M/966	antipersonnel	metal	---
Portugal	M432 (Bounding)	antipersonnel	metal	---

Country of Origin	Model Designation	Type of Munition	Case Material	Remarks
Portugal	M/966-B	antipersonnel	metal	---
Portugal	M421	antipersonnel	metal	---
Romania	MSS	antipersonnel	metal	---
Romania	MC-71	antitank	metal	---
Romania	MAT-46	antitank	metal	---
Romania	MAI-68	antipersonnel	metal	---
South Africa	Shrapnel Mine No. 2 (M18A1 copy)	---	---	---
South Africa	Ambush, Frag	antipersonnel	sheet metal	---
South Korea	M16A2 (copy)	antipersonnel	sheet steel	---
South Korea	K440 (M18A1 copy)	---	---	---
South Korea	M19 (copy)	antitank	---	---
Spain	F.42	antitank	metal	---
Spain	PS-1 and PS-1A	antipersonnel	steel	---
Spain	M45B (Bounding)	antipersonnel	metal	---
Sweden	FFV 018	antitank	metal	---
Sweden	Truppmina 9	antipersonnel	metal	---
Sweden	M/48 (Service) and M/48 (Practice)	antipersonnel	steel	---
Sweden	FFV 028	antitank	steel	---
Sweden	FFV-016	antivehicle	metal	---
Sweden	9 (Illuminating, Signal, Sound, and Practice)	antipersonnel	steel	---
Sweden	FFV 028 SN (self-neutralizing)	antitank	steel	---
Sweden	M/41-47 and Practice	antitank	steel	---
Sweden	FFV 028RU (reusable) and FFV 028SD (self-destructing)	antitank	steel	---
Sweden	M/47B, C, D, and Practice, M/47-52B	antitank	steel	---
Switzerland	DM-31	antitank	sheet metal	---

Country of Origin	Model Designation	Type of Munition	Case Material	Remarks
Switzerland	49	antitank	steel	---
Switzerland	37	antitank	sheet steel	---
Taiwan	M2 (copy)	antipersonnel	metal	---
Taiwan	TC 68 (Bounding)	antipersonnel	metal	---
Taiwan	68 (Bounding)	antipersonnel	metal	---
Turkey	4.5 KG	antitank	sheet steel	---
Turkey	9.9-LB	antitank	galvanized sheet steel	---
Turkey	4.4-LB	antitank	galvanized sheet steel	---
United Kingdom	Alarm	flare	metal	---
United Kingdom	AHM/EFP warhead	antihelicopter	metal	Applicable only if buried in soil
United Kingdom	MK-2 (Trip flare)	antipersonnel	metal	---
United Kingdom	MK 5 H.C.	antitank	steel	---
United Kingdom	Anti-tire with fuze	antipersonnel	steel	---
United Kingdom	GS MK 2(II)	antitank	steel	---
United Kingdom	HB 876	antipersonnel	metal	---
United Kingdom	ADDER	antitank	metal	---
United Kingdom	No. 75 MK II	antitank	metal	---
United Kingdom	No. 4 with fuze, EP	antipersonnel	sheet metal	---

Country of Origin	Model Designation	Type of Munition	Case Material	Remarks
United Kingdom	No. 75 MK 1 (Grenade Modified)	antipersonnel	metal	---
United Kingdom	MK 1 & 2(II) (Shrapnel)	antipersonnel	steel	---
United Kingdom	Ointment Box	antipersonnel	sheet steel	---
United Kingdom	EP MK 5(V)	antitank	sheet metal	---
United Kingdom	GS MK 3(III)	antitank	tin plate/steel	---
United Kingdom	No. 3 MK 1 with fuze	antipersonnel	steel	---
United Kingdom	EP MK 2(II)	antitank	steel	---
United Kingdom	EP MK 56(VI)	antitank	sheet metal	---
United Kingdom	GS MK IV & GS MK VC	antitank	steel	---
United Kingdom	GS MK V(5) & GS MK V(5) HC	antitank	steel	---
United Kingdom	Mark 5, H.C.	antitank	steel	---
United Kingdom	MK 7, MK 7/1, MK 7/4 & MK 7/7	antitank	metal	---
United Kingdom	Mark 1	antitank	steel	---
United Kingdom	Mark 7	antitank	metal	---
U.S.S.R.	Improved OZM	antipersonnel	steel	---
U.S.S.R.	MZ	antipersonnel	steel	---
U.S.S.R.	PMM-3	antipersonnel	sheet metal	---

Country of Origin	Model Designation	Type of Munition	Case Material	Remarks
U.S.S.R.	KHF-2 Chemical	antipersonnel	sheet metal	---
U.S.S.R.	OZM-160	antipersonnel	metal	---
U.S.S.R.	OZM-72	antipersonnel	sheet steel	---
U.S.S.R.	AKS	antitank	sheet metal	---
U.S.S.R.	TM-35	antitank	sheet metal	---
U.S.S.R.	TM-39	antitank	sheet metal	---
U.S.S.R.	UI-TM-60 Simulator	antitank	sheet metal	---
U.S.S.R.	OZM-4 (Bounding)	antipersonnel	metal	---
U.S.S.R.	LMG	antitank	metal	---
U.S.S.R.	TM-38	antitank	heavy sheet steel	---
U.S.S.R.	TM-72	antitank	metal	---
U.S.S.R.	MON-50 (M18A1 copy)	---	---	---
U.S.S.R.	MON-100	antipersonnel	sheet steel	---
U.S.S.R.	MON-200	antipersonnel	sheet steel	---
U.S.S.R.	PMN-4	antipersonnel	metal	---
U.S.S.R.	POM-1 and POM-1S (BLU 42B copy)	antipersonnel	steel	---
U.S.S.R.	TM-41	antitank	metal	---
U.S.S.R.	TM-46 & TMN-46; and Training, UITM-46	antitank	steel	---
U.S.S.R.	PMP	antipersonnel	steel	---
U.S.S.R.	TM-44	antitank	metal	---
U.S.S.R.	TM-57	antitank	steel	---
U.S.S.R.	TM-62M	antitank	metal	---
U.S.S.R.	TM-83	antitank	metal	---
U.S.S.R.	TMK-2	antitank	steel	---
U.S.S.R.	PMZ-40	multipurpose	pressed steel	---
U.S.S.R.	TM-62P2	antitank	metal	---
U.S.S.R.	TM-89	antitank	steel	---

Country of Origin	Model Designation	Type of Munition	Case Material	Remarks
U.S.S.R.	SM	signal	sheet metal	---
U.S.S.R.	UI-POM-2S (Training)	antipersonnel	steel	---
U.S.S.R.	PFM-1 Butterfly (BLU-43/B copy)	antipersonnel	---	---
Vietnam	anti-helicopter	antipersonnel	---	---
Vietnam	MDH-3	antipersonnel	Sheet metal	---
Vietnam	MBV-78-A1	antipersonnel	metal	---
Vietnam	MD-82-B	---	---	---
Vietnam	MDH-4K	antipersonnel	metal	---
Vietnam	MDH-8K	antipersonnel	metal	---
Vietnam	MDH-10K	antipersonnel	metal	---
Vietnam	P-40 Ballmine	antipersonnel	metal	---
Vietnam	U/I VM	antitank	metal	---
Vietnam	U/I VM AP	antipersonnel	metal	---
Vietnam	Turtle-Shaped	antiperson/material	sheet metal	---
Vietnam	Fougasse, VCONG	antipersonnel	galvanized pipe	---
Vietnam	Cylinderical, Elongated	antipesonr/material	sheet metal	---
Vietnam	VCONG	antiperson/material	metal	---
Vietnam	M1, Round	antitank	metal	---
Vietnam	M1, Square	antitank	metal	---
Vietnam	MDH-8K	antipersonnel	metal	---
Vietnam	MDH-2	antipersonnel	metal	---
Vietnam	MDH-5	antipersonnel	metal	---
Vietnam	MCX 7A (Min CHIEN XA)	antivehicle	thin sheet metal	---
Vietnam	MDH-10	antipersonnel	metal	---
Vietnam	MDH-4K	antipersonnel	metal	---
Vietnam	DH-3 Rectangle (MIN., Directional, Frag)	antipersonnel	sheet metal	Applicable only if buried in soil

Country of Origin	Model Designation	Type of Munition	Case Material	Remarks
Vietnam	MDH Type	antiperson/material	metal	---
Vietnam	MBV-78A2	antipersonnel	metal	---
Vietnam	DH-3 Circle (MIN., Directional, Frag)	antipersonnel	sheet metal	Applicable only if buried in soil
Vietnam	Pipe or Shell Casing	antipersonnel	metal	---
Vietnam	Improvised US 40-mm Grenade	antipersonnel	metal	---
Vietnam	MDH-C40	antipersonnel	metal	---
Vietnam	With Reverse-Action Fuze K7	antipersonnel	steel	---
Vietnam	DH-10 (Dual-Purpose, Frag, Dir.)	antipersonnel/tank	metal	---
Vietnam	Pineapple-Shaped	fragmentation	metal	---
Vietnam	NOM Z2B (Bounding)	antipersonnel	metal	---
Yugoslavia	UDAR	antipersonnel	steel	---
Yugoslavia	Ricochet (Expanding)	antipersonnel	metal	---
Yugoslavia	PROM-1 (Bounding, Frag) and VPROM-1 (Practice)	antipersonnel	steel	---
Yugoslavia	PMR-1	antipersonnel	cast steel	---
Yugoslavia	PMR-2A	antipersonnel	steel	---
Yugoslavia	PROM-KD (Bounding)	antipersonnel	metal	---
Yugoslavia	PROM 2 (Bounding)	antipersonnel	metal	---
Yugoslavia	PMR-3 and Practice VPMR-3	antipersonnel	steel	---
Yugoslavia	PMRS	antipersonnel	steel	---
Yugoslavia	TMM-1	antitank	steel	---
Yugoslavia	Metal Pot Mine	antitank	sheet metal	---
Yugoslavia	YU-S-AT	antitank	metal	---

Table 2. Applicable U.S. Mines Listed in ORDATA II Database

Country of Origin	Model Designation	Type of Munition	Case Material	Mine Specification	Case Specification
United States	BLU-24B/B	antipersonnel	metal	---	---
United States	BLU-42/B	antipersonnel	metal	---	---
United States	M1	antitank	steel	---	---
United States	M1A1	antitank	metal	---	---
United States	M1 and M1B1	practice	steel	---	---
United States	M1, M1A1 and M4	antitank	steel	---	---
United States	M2	antipersonnel	metal	---	---
United States	M2A3 (M2 with minor design improvements)	antipersonnel	metal	---	---
United States	M2A3B1 (M2 with minor dsgn improvements)	antipersonnel	metal	---	---
United States	M2 Series	antipersonnel	steel	---	---
United States	M2A3 and M2A4 Group	antipersonnel	steel	---	---
United States	M4	antitank	steel	---	---
United States	M6A2	antitank	metal	---	---
United States	M6A2	---	---	---	---
United States	M6 Series	antitank	sheet metal	---	---
United States	M7A1	antitank	steel	---	---
United States	M7, M7A1 & M7A2 & Inert , M7, M7A1, & M7A2	antitank	steel	---	---
United States	M8A1	practice	steel	---	---
United States	M10 and M10A1	practice	steel	---	---
United States	M12, M12A1, and M20	practice	sheet metal	---	---
United States	M15 Heavy with M600, M601, & M603 Fuzes	antitank	sheet metal	---	---
United States	M16 (with M605 fuze)	antipersonnel	steel	---	---
United States	M20	---	---	---	---

Country of Origin	Model Designation	Type of Munition	Case Material	Mine Specification	Case Specification
United States	M21 (Heavy)	antitank	steel	MIL-M-45405	ASTM-A619/ASTM-A620
United States	M21	antitank	steel	---	---
United States	M24	antitank	metal	---	---
United States	M26 (Bounding)	antipersonnel	metal	MIL-M-60923	QQ-A-591/MIL-C-50
United States	M34	antitank	metal	---	---
United States	M35	---	---	---	---
United States	M66	antitank	steel	---	---
United States	M69 Practice	antitank	steel	---	---
United States	M66 and Practice M69	antitank	steel	---	---
United States	M75	antitank/antivehicle	steel	MIL-M-63305	ASTM-A519
United States	M86	antipersonnel	steel	MIL-M-70696	---
United States	M131	---	steel	MIL-D-48688	ASTM-A519/ASTM-A620
United States	For M131 Modular Pack Mine System (MOPMS)	antipersonnel	scored steel	---	---
United States	M131 Modular Pack Mine System (MOPMS)	antitank	steel	---	---
United States	M139 Multiple Delivery Mine System	antipersonnel	steel	---	---
United States	M139 Multiple Delivery Mine System	antitank	steel	---	---
United States	For M139 (Multiple Delivery Mine System) Volcano	antipersonnel	scored steel	---	---
United States	For M139 Multiple Delivery Mine System (Volcano)	antitank	steel	---	---
United States	M147 (Time delay firing device)TDFD	firing device	metal	---	---
United States	M381	---	---	---	---
United States	M600	---	---	---	---

Country of Origin	Model Designation	Type of Munition	Case Material	Mine Specification	Case Specification
United States	M601	---	---	---	---
United States	M603	---	---	---	---
United States	MK-62 MOD 0 (Quickstrike)	shallow bottom	steel	---	---
United States	T8E1 (Practice)	antitank	steel	---	---
United States	XM54 (Pop-up PWP)	antipersonnel	metal	---	---